IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 15, Issue 6 Ser. I (Nov – Dec 2019), PP 08-11
www.iosrjournals.org

Note on Mathematical Modeling for Population Projection and Management: A Case Study of Niger State

Umar Muhammad Abubakar[1] and Salisu Usaini [2]
[1, 2] *Department of Mathematics, Kano University of Science and Technology, Wudil, P.M.B.3244, Kano, Nigeria*

Abstract: *In this note, we review the work of Abubakar et al [1] and correct the value of the population growth rate which was wrongly calculated. We examine the difference between the new and the old population projection growth by finding the absolute percentage error as presented in Table 2 and graphically in Figure 1.*
Keywords: *Census, Malthusian law, mathematical modeling, Population, Projection, Birth and Death rate*

Date of Submission: 17-10-2019 Date of acceptance: 01-11-2019

I. Introduction

Census in Nigeria is very delicate and sensitive issue even before the first census exercise that combined both Northern and Southern protectorates in 1952 as it affects most of the government policies and the allocation of federal grants and subsidies. Aluko [4] discussed census problems and implications between 1901 and 1963 and concluded that no true and acceptable figures were produced. Adegbile [2] in his paper "Eighty million Nigerians and their future: a commentary on the 1973 census" give an insight on possible implications of the census figures. Compbell [5] discussed civil-military census relation. Okolo [9] review pre-independence and post-independence censuses in Nigeria and try to identify the factors that contributed to the failure of the census and distrustful public attitude toward the census exercise and offer suggestions on how to overcome the problems. Ezeah et al [6] gives explanation to the socio-economic and political problems associated with the census figures in Nigeria and a way to reduce negative perceptions of the census figures.

Many researchers follow statistical and mathematical approach to test the validity and accuracy of Nigeria 2006 population census figures. Ikoba et al [7] used Benford first significant digit law to test the randomness and non-uniformly distribution of 774 local government area census figures. Okechi [8] used statistical technique such as whipple's index (index of concentration) and other age accuracy index to investigate accuracy of Nigeria 2006 population census figures. Abubakar et al [1] developed mathematical model for population projection and management of Niger state for the period of 20 years using 2006 census figures from National Population Commission with birth and death rates from American Central Intelligence Agency: World Fact Book of Nigeria given by 38.03 births per 1 000 populations and 13.16 deaths per 1 000 populations respectively. The purpose of this note is to correct the error made by Abubakar et al [1] on the birth and growth rates as 0.03803 and 0.02487 instead of 0.3803 and 0.025643, respectively.

1.1 Objective of the Study

The objective of this note is to present the accurate projected population of Niger state using exponential growth model for the period of 20 years from 2006 to 2026 in order to forecast the future census figures.

II. Method and Data Gathering

In this note we used secondary data obtained by Abubakar et al [1] from the following sources: (1) National Population Commission; (2) American Central Intelligence Agency: The World Fact Book

2.1 Exponential Growth Model

Exponential growth model or exponential law also called Malthusian growth model or Malthusian law for population growth was the first growth model developed by Thomas Robert Malthusian in 1798 under the assumption that the time rate of change of population is proportional to the present population:

$$\frac{dP}{dt} = \gamma P \tag{1}$$

where γ is the difference between birth rate β and death rate δ called population growth rate. Equation (1) is variable separable ordinary differential equation, so on solving this equation; we obtained solution of the following form:

$$P = \psi e^{\gamma t} \tag{2}$$

To obtain the complete solution we used initial condition $P = P_o$ when $t = 0$, that is

$$P(0) = P_0 = \psi \tag{3}$$

Using (3) in (2) yields:

$$P = P_0 e^{\gamma t} \tag{4}$$

Where t is the difference between base year and present year, and P_0 is the population at the base year.

2.2 Evaluation of the Model

This model assumed that the reproductive rate is carried out continuously by it members without regard to gender, age or sex difference and the environment inhabitant by the population is closed. Based on the data of the population collected According to the American Central Intelligence Agency: the world fact book, the birth rate, β and death rate, δ of Nigeria as in 2006 are 38.03 birth per 1 000 populations and 13.16 deaths per 1 000 populations respectively.
Now

$$\gamma = \beta - \delta = 0.02487 \tag{5}$$

Using (5) in to equation (4) gives:

$$P(t) = 3\,950\,249 e^{0.02487t} \tag{6}$$

By using equation (6), the predicted population at time $t = 0$ is as follows:

$$\begin{aligned} P(0) &= 3\,950\,249\, e^{0.02487(0)} \\ &= 3\,950\,249 \end{aligned} \tag{7}$$

Using similar argument the values of $P(1)$ to $P(20)$ are shown in Table 2.

III. Results

The summary of the Population figure from National Population Commission, census 2006 as specified in the manuscript by Abubakar et al [1] and Adeline et al [2] is as presented in Table 1.

Table 1: Population figure from National Population Commission, census 2006

State	Total Population	State	Total Population	State	Total Population
Abuja (FCT)	1,405,201	Ekiti	2,384,212	Adamawa	3,168,101
Abia	2,833,999	Ogun	3,658,098	Bauchi	4,676,465
Anambra	4,182,032	Ondo	3,441,024	Borno	4,151,193
Ebonyi	217,501	Osun	3,423,535	Gombe	2,353,879
Enugu	3,257,298	Oyo	5,591,589	Taraba	2,300,736
Imo	3,934,899	Lagos	9,013,534	Yobe	2,321,591
Akwa-ibom	3,920,208	Benue	4,219,244	Jigawa	4,348,649
Bayelsa	1,703,358	Kogi	3,258,487	Kaduna	6,066,562
Cross-River	2,888,986	Kwara	2,371,089	Kano	9,383,682
Delta	4,098,391	Nassarawa	1,865,275	Katsina	5,792,578
Edo	3,218,332	Niger	3950,44	Kebbi	3,238,628
Rivers	5,185,400	Plateu	3,178,712	Sokoto	3,696,999
				Zamfara	3,259,846

The table 2 below shows the result of the old and new population projection base on the developed model:

Table 2: Comparison table for the Old and New Predicted value of the Population

S/N	Time	*t*	Old Projected Population	New Projected Population	Absolute percentage error (%)	S/N	Time	*t*	Old Projected Population	New Projected Population	Absolute percentage error (%)
1	2006	0	3,950,249	3,950,249	0.0000	12	2017	11	5,237,538	5,193,192	0.8539
2	2007	1	4,052,855	4,049,724	0.0773	13	2018	12	5,373,581	5,323,967	0.9319
3	2008	2	4,158,127	4,151,703	0.1547	14	2019	13	5,513,158	5,458,034	1.0100
4	2009	3	4,266,132	4,256,251	0.2322	15	2020	14	5,656,360	5,595,433	1.0889
5	2010	4	4,376,943	4,363,410	0.3101	16	2021	15	5,803,282	5,736,382	1.1662
6	2011	5	4,490,633	4,473,310	0.3873	17	2022	16	5,954,020	5,880,834	1.2445
7	2012	6	4,607,275	4,585,956	0.4649	18	2023	17	6,108,673	6,02,924	1.3228
8	2013	7	4,726,947	4,701,439	0.5426	19	2024	18	6,267,344	6,180,744	1.4011
9	2014	8	4,849,728	4,819,830	0.6203	20	2025	19	6,430,136	6,336,386	1.4796
10	2015	9	4,975,698	4,941,302	0.6961	21	2026	20	6,597,156	6,495,948	1.5580
11	2016	10	5,104,940	5,065,631	0.7760						

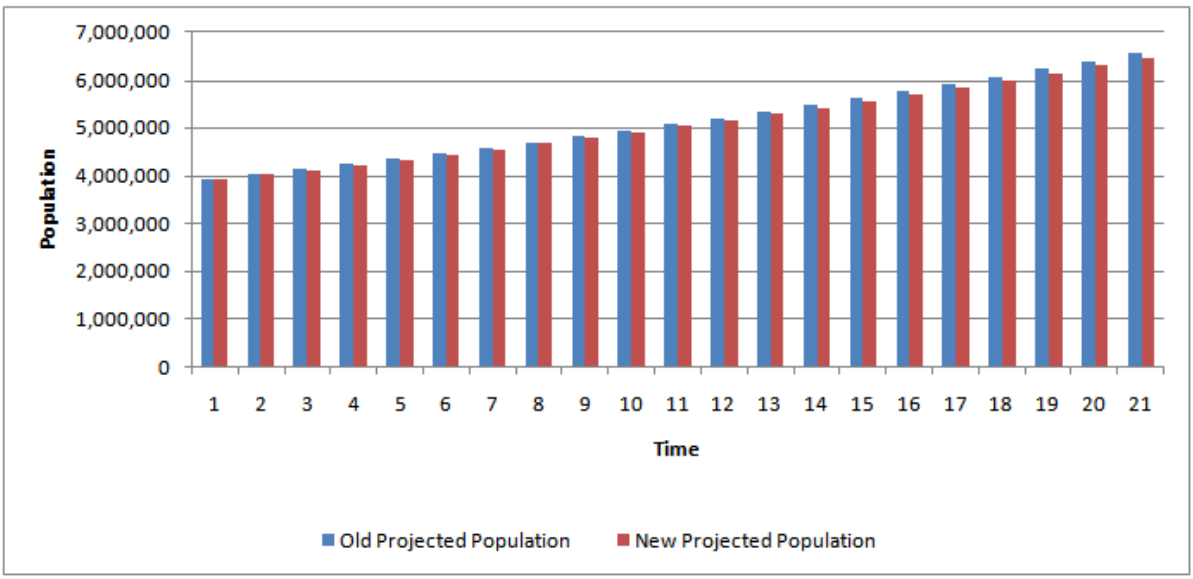

Figure 1: Graph comparison of the Old and New Predicted value of the Population

Interpretation: The above graph shows the difference between old and new projected population against time. The values were calculated using exponential growth model**.**

VI. Conclusion

In this note, we give corrected value of population growth rate and projected population growth of Niger state using exponential growth model for the period of 20 years from 2006 to 2026. We examined the difference between the new and old population projection growth by finding the absolute percentage error across the data in Table 2 and also give comprehensive comparative relations between our result and Abubakar et al [1] in Figure 1 diagrammatically.

References

[1]. Abubakar, Y. A., Audu, P. M. and Aisha, H. S. (2017). Mathematical modeling for population and management: A case study of Niger state. International Journal of Science and Research, 13 (5), 51-57. http://dx.doi.org/10.9790/5728-1305035157.

[2]. Adegbile, I. O. (1975). Eighty Nigerians and their future: a commentary on the 1973 census. Africa to day, 22 (1), 63-65.

[3]. Adeline, I.A., and Eme, O. I. (2015). Census politics in Nigeria: An examination of 2006 population cencus. Journal of Policy and Development Studies, 9 (3), 47-72.

[4]. Aluko, S. A. (1965). How many Nigerians? An Analysis of Nigeria's Census Problems, 1901-1963. The Journal of Modern African Studies, 3(3), 371-392.

[5]. Compbell, I. (1976). The Nigerian census: An essay in civil-military relation. The Journal of Commonwealth and Comparative Politics, 4(3), 242-254.

[6]. Ezeah, P., Iyanda, C. and Nwanga, C. (2013). Challenges of National Population Census and Sustainable Development in Nigeria: A theoretical Exposition. IOSR Journal of Humanities and Social Science, 18 (1), 50-56.

[7]. Ikoba, N.A., Jolayemi, E.T. and Sanni, O.M. (2018). Nigeria's recent population censuses: A Benford theoretical evaluation. African Population Studies, 32(1), 3974-3981.

[8]. Okechi, O.S. (2016). 2006 Nigeria Population Census and Errors in Age Reporting: A Critical Assessment of the Priority Table. Conference Paper Presented at the Biennial Conference on interdisciplinary studies (BCIS) organized by the faculty of Management and Social Science Godfrey Okoye University, Enugu, Enugu State, Nigeria.

[9]. Okolo, A. (1990). The Nigerian Census: Problems and Prospects. The American Statistician, 53(4), 321-325.8

Umar Muhammad Abubakar. "Note on Mathematical Modeling for Population Projection and Management: A Case Study of Niger State." IOSR Journal of Mathematics (IOSR-JM) 15.6 (2019): 08-11.